

Shawn K. Kelly

skkelly@cmu.edu

<http://www.andrew.cmu.edu/user/skkelly>

Education

- **Massachusetts Institute of Technology, Cambridge, MA**
 - Ph.D., Electrical Engineering, October, 2003
 - “A System for Efficient Neural Stimulation with Energy Recovery”
 - Supervisor: John L. Wyatt
- **Massachusetts Institute of Technology, Cambridge, MA**
 - M.Eng., Electrical Engineering, June 1998
 - “A System for Electrical Retinal Stimulation for Human Trials”
 - Supervisor: John L. Wyatt
- **Massachusetts Institute of Technology, Cambridge, MA**
 - S.B., Electrical Engineering, June 1996
 - Minor in Biology; Minor in Biomedical Engineering; Supervisor: Steven Leeb
 - “A Marking and Identification System for Locating Faulty Assembly Line Parts”

Primary Interests

- Medical device product design, development, and packaging
- Analog and mixed signal VLSI circuit design
- Retinal prostheses, EEG systems, implantable microelectronic medical devices
- Electrical tissue stimulation, neuromodulation, current source stimulation circuitry, stimulating electrode materials
- Wireless power/data telemetry, power management, micro-power management circuits

Current Positions

2013 – Present Research Biomedical Engineer at VA Pittsburgh Healthcare System

2012 – Present Senior Systems Scientist at Carnegie Mellon University

Developing and testing a prototype implantable retinal prosthesis for the blind for over 20 years with the Boston Retinal Implant Project, a joint effort of the VA, MIT, CMU, and Massachusetts Eye and Ear Infirmary. Our group has successfully built three different generations of wirelessly-powered prostheses and implanted them chronically in animals in preparation for clinical trials.

I lead the electrical system design for our high-channel-count implant, I design the inductively coupled power and data telemetry systems for the prosthesis, and I coordinate implant component assembly by outside vendors and prototype testing.

I founded the Neural Devices Engineering Laboratory at CMU, where my group designs and builds circuits and mechanical fixtures to test stimulation and telemetry systems for medical implants.

Previous Experience

- **Shawn Kelly Consulting – Principal, 2006 – Present**
Consultant to six startup companies developing medical devices. Designed electrode test circuits, advised the design of telemetry systems, neurostimulators, and hermetic packages.
- **Research Health Scientist at VA Boston Healthcare System, 2003 – 2012**
- **Visiting Scientist at MIT, 2003 – 2011**
- **MIT Graduate Research Assistant – Ph.D., 1999 – 2003**
Designed, laid out, and had fabricated a VLSI chip and power coupling system for low-power neural stimulation, which used 66% less power than the most efficient stimulator in use (US Patent #7,295,872).
- **MIT Graduate Research Assistant – M.Eng., 1997 – 1999**
Designed battery-powered retinal stimulator, used in 6 human surgical trials.

- **M/A-Com Microwave Test Engineer, 1996**
Designed 50 GHz test system; used skeleton system to test p-i-n diode parameters.
- **MIT Advanced Undergraduate Project, 1996**
Designed simple mechanical ink ejection system to mark faulty assembly line parts.
- **MIT Undergraduate Research, 1992 – 1995**
Determined cartilage mechanical properties under static and dynamic compression.
- **University of Pittsburgh Summer Research, 1995**
Developed circuitry to measure resistivity of brain tissue and cerebrospinal fluid; wrote Matlab models of current distributions near multiple resistivity boundaries.
- **University of Pittsburgh Summer Research, 1994**
Developed experimental hardware/software system for hydrostatic cartilage testing.

Teaching Experience

- CMU 18-500 – ECE Design Experience. Fall '18,'19
- CMU 18-220 – Electronic Devices and Analog Circuits. Spring '14,'16,'18,'19, Fall '14 – 19
- CMU 18-412/18-612 – Neural Technology, Sensing, and Stimulation. Fall '12,'13, Spring '15,'17,'19
- U. Pitt, Guest Lecturer, Neurotechnology: Concepts, Patients, and Devices. Spring 2012
- MIT Teaching Assistant, 6.111 – Digital Electronics Laboratory. Fall 1996
- MIT Educational Studies Program, Physics Advisor for summer program. 1996, 1997
- MIT Laboratory Assistant, 6.111 – Digital Electronics Laboratory. Spring 1996
- MIT Experimental Studies Group, taught section of 5.11 – Chemistry. Fall 1995
- MIT Computer Laboratory Assistant, 6.001 – Programming. Spring 1994

Student Advising

- Advised a wide range of Masters and Undergraduate students at CMU, Departments of Electrical and Computer Engineering and Biomedical Engineering, 2011-Present
- Ph.D. Thesis Supervisor, CMU, Dept. of Electrical and Computer Eng., 2011-2016.
- Ph.D. Thesis Reader, U. of New South Wales, Graduate School of Biomed. Eng., 2008.
- M.S. Thesis Committee, Tufts U., Dept. of Electrical and Computer Eng., 2008.
- Science advisor, MIT Sloan business students developing a retinal implant business plans, 2007, 2008.
- Ph.D. Thesis Design Review Committee, Tufts U., Dept. of Electrical and Computer Eng., 2006.
- Science Advisor, Boston College business students writing a retinal implant business plan for a class competition, 2005, 2006. My team won in 2006.
- Industry Advisor, Rhode Island School of Design (RISD) student designing a mockup retinal implant eyewear, processor, and telemetry unit, 2005.
- Science Advisor, MIT Sloan business students writing a retinal implant business plan for the MIT 50K design competition, 2004.

Leadership/Activities

- Treasurer, Board of Directors, Pittsburgh Entrepreneurs Forum. 2012 – present
- Advisory Board, CCNY-GaTech Man Machine Motor Control for the Blind. 2012 – 2016
- Board of Directors, Science for the Public. 2010 – 2013
- Advisory Board (Co-chair), MIT Tech Catholic Community. 2005 – 2011
- Volunteer math and science tutor for ESL adult education program. 2003 – 2008
- Strategic Advisory Committee to the Chancellor, MIT. 1999 – 2000
- Dormitory President, member of the MIT Dormitory Council. 1995 – 1996

Awards/Honors

- Baldwin High School Distinguished Highlander Hall of Fame. 2015
- Best Paper Award, IEEE ISABEL conference. 2009
- VA Career Development Award. 2008 – 2011
- Catalyst Foundation Fellowship. 1998 – 2003
- Richard P. Simmons '53 Scholarship. 1992 – 1996
- Bell of Pennsylvania Scholarship. 1992 – 1996
- United States Presidential Scholar. 1992

Memberships

- IEEE Senior Member. M 2003; SM 2014
- Sigma Xi Scientific Research Society. 2002

Selected Research Funding

NSF STTR; \$225,000; 2019 – 2020

Principal Investigator, Precision Neuroscopics

“Portable Ultra-resolution EEG for Improved Diagnosis and Treatment of Brain Disorders: Instrumentation and Algorithms”

VA Rehabilitation R&D; \$199,991; 2019 – 2020

Principal Investigator

“Development of Ultra-high-density Packaging for Implantable Neural Devices”

VA Rehabilitation R&D; \$1,099,952; 2013 – 2017

Principal Investigator

“Power and Data Telemetry System for a 256-Channel Retinal Implant”

NIH ARRA; \$2,279,562; 2009-2011

Co-Investigator

“Advanced Engineering Development of a Chronic Retinal Implant”

VA Rehabilitation R&D; \$473,675; 2008 – 2011

Principal Investigator; Career Development Award

“Improved Power and Data Telemetry System for Implanted Medical Devices”

Department of Defense; \$2,156,000; 2007 – 2009

Principal Investigator for BVARI sub-contract

“Optimization of Microelectronic Methods to Produce an Implantable Retinal Prosthesis”

VA Rehabilitation R&D; \$3,750,000; 2001 – 2006; \$3,400,000; 2006 – 2010

Co-Investigator

“Center for Innovative Visual Rehabilitation”

Journal and Conference Reviewing

IEEE Trans. on Biomed. Eng.

IEEE Eng. in Med. and Bio. Conf.

IEEE Trans. on Biomed. Circ. and Sys.

IEEE Biomed. Circ. and Sys. Conf.

IEEE Int'l Symposium on Circ. and Sys.

IEEE Asian Solid-State Circ. Conf.

Investigative Ophth. and Vis. Sci.

J. Neural Eng.

IEEE Int'l Symposium on Applied Sciences in Biomed. and Comm. Technologies

US Patent

S.K. Kelly, J.L. Wyatt, J.F. Rizzo. “System for and Method of Power Efficient Electrical Tissue Stimulation.” United States Patent #7,295,872, November 2007.

Selected Publications

M. Gopakumar, J. Cao, S.K. Kelly, P. Grover. "Cell-type Selective Stimulation of Neurons Based on Single Neuron Models." Proc. IEEE EMBS Conf. on Neural Engineering, 2019, pp. 411-414.

Z. Ahmed, J. Reddy, K. Deshpande, A. Krishnan, P. Venkatesh, S.K. Kelly, P. Grover, M. Chamanzar. "Flexible Ultra-resolution Subdermal EEG Probes." Proc. IEEE Biomedical Circuits and Systems Conference, 2018.

A. Krishnan, R. Kumar, P. Venkatesh, S.K. Kelly, P. Grover. "Low-cost Carbon Fiber-based Conductive Silicone Sponge EEG Electrodes." Proc. IEEE Engineering in Medicine and Biology Conference, 2018, pp. 1287-1290.

A. Krishnan, R. Kumar, A. Etienne, A. Robinson, S.K. Kelly, M. Behrmann, M. Tarr, P. Grover. "Challenges and Opportunities in Instrumentation and Use of High-Density EEG for Underserved Regions." Accepted paper, InterSol, Kigali, Rwanda 2018.

S.K. Kelly and J.F. Rizzo. "The Boston Retinal Implant." Chapter in *Artificial Vision: A Practical Guide*. P. Gabel (ed.), Springer New York, 2017.

S.K. Kelly. "Adiabatic Electrode Stimulator." Chapter in *Handbook of Biochips: Integrated Circuits And Systems for Biology and Medicine*. M. Sawan (ed.), Springer New York, 2016.

A. Yousif, S.K. Kelly. "Development of High Impedance Measurement System for Water Leakage Detection in Implantable Neuroprosthetic Devices." IEEE Eng. in Medicine and Biology Conf, pp. 4865-4868, 2016.

C.H. Lin, A. Krishnan, S.K. Kelly. "Current versus Timing Control in Active Anodic Feedback of Biphasic Stimulation." IEEE Eng. in Medicine and Biology Conf. 2016.

A. Hezarkhani, S.K. Kelly. "Blocked-watershed Method: A Saliency-based Optimization of the Watershed Transformation for Low Resolution Retinal Prosthesis." IEEE Eng. in Medicine and Biology Conf. 2016.

S.K. Kelly, W. Eilersick, A. Krishnan, P. Doyle, D.B. Shire, J.L. Wyatt, J.F. Rizzo. "Redundant Safety Features in a High-Channel-Count Retinal Neurostimulator." Trans. IEEE Biomedical Circuits and Systems Conference, 2014, pp. 216-219.

A. Krishnan, S.K. Kelly. "On the Cause and Control of Residual Voltage Generated by Electrical Stimulation of Neural Tissue." IEEE Eng. in Medicine and Biology Conf., pp. 3899-3902, 2012.

S.K. Kelly, D.B. Shire, J. Chen, P. Doyle, M.D. Gingerich, S.F. Cogan, W. Drohan, S. Behan, L. Theogarajan, J.L. Wyatt, J.F. Rizzo. "A Hermetic Wireless Subretinal Neurostimulator for Vision Prostheses." IEEE Trans. on Biomedical Eng., Vol. 58, No. 11, pp. 3197-3205, 2011.

S.K. Kelly, D.B. Shire, J. Chen, P. Doyle, M.D. Gingerich, S.F. Cogan, W. Drohan, L. Theogarajan, J.L. Wyatt, J.F. Rizzo. "Communication and Control System for a 15-Channel Hermetic Retinal Prosthesis." Biomed. Sig. Proc. and Control, Vol. 6, No. 4, pp. 356-363, 2011.

D.K. Freeman, J.S. Jeng, S.K. Kelly, E. Hartveit, S.I. Fried. "Calcium Channel Dynamics Limit Synaptic Release in Resonse to Prosthetic Stimulation with Sinusoidal Waveforms." Journal of Neural Engineering, Vol 8, pp. 046005-1 – 046005-19, 2011.

S.K. Kelly, J.L. Wyatt. "A Power-Efficient Neural Tissue Stimulator with Energy Recovery." IEEE Trans. on Biomedical Circuits and Systems, Vol. 5, No. 1, pp. 20-29, 2011.

S.K. Kelly, D.B. Shire, J. Chen, P. Doyle, M.D. Gingerich, W.A. Drohan, L.S. Theogarajan, S.F. Cogan, J.L. Wyatt, J.F. Rizzo. "The Boston Retinal Prosthesis: A 15-Channel Hermetic Wireless Neural Stimulator." IEEE ISABEL conference, 2009. Best Paper Award.

D.B. Shire, S.K. Kelly, J. Chen, P. Doyle, M.D. Gingerich, S.F. Cogan, W. Drohan, O. Mendoza, L. Theogarajan, J.L. Wyatt, J.F. Rizzo. "Development and Implantation of a Minimally-Invasive, Wireless Subretinal Neurostimulator" IEEE Trans. on Biomed. Eng, 56(10) pp. 2502-2511, 2009.

S.K. Kelly, J. Wyatt. "A Power-Efficient Voltage-Based Neural Tissue Stimulator with Energy Recovery." IEEE Int'l Solid-State Circuits Conf., paper 12.6, pp. 228-524, Vol. 1, 2004.

J.F. Rizzo, J.L. Wyatt, J. Loewenstein, S.K. Kelly, D.B. Shire. "Methods and Perceptual Thresholds for Short-Term Electrical Stimulation of Human Retina with Microelectrode Arrays." Invest. Ophth. and Vis. Sci. (IOVS), Vol. 44, No. 12, pp. 5355-5361, 2003.

J.F. Rizzo, J.L. Wyatt, J. Loewenstein, S.K. Kelly, D.B. Shire. "Perceptual Efficacy of Electrical Stimulation of Human Retina with a Microelectrode Array During Short-Term Surgical Trials." IOVS, Vol. 44, No. 12, pp. 5362-5369, 2003.

S.B. Baumann, D.R. Wozny, S.K. Kelly, F.M. Meno. "The Electrical Conductivity of Human Cerebrospinal Fluid at Body Temperature." IEEE Trans. on Biomedical Engineering, Vol. 44, No. 3, pp. 220-223, 1997.

Selected Conference Abstracts

S.K. Kelly. "Impedance Measurement System to Predict Implantable Package Lifetimes." Minnowbrook Microelectronics Conference, 2019.

S.K. Kelly. "Scaling Neural Interface Hardware to 1000 Channels and Beyond." Neural Interfaces Conference, 2016.

S.K. Kelly. "High-Density Retinal Prosthesis." Vision Restoration: Regenerative Medicine in Ophthalmology, 2016.

S.K. Kelly. "Traditional and Adiabatic Neural Stimulator Circuits." Half-Day Tutorial at IEEE NEWCAS Conference, 2014.

S.K. Kelly, W.F. Ellersick, A.A. Priplata, D.B. Shire, J.L. Wyatt, J.F. Rizzo. "Power and Data Telemetry Developments for a Retinal Implant." IOVS, Vol. 53: 5516, 2012.

S.K. Kelly. "The Boston Retinal Implant Project: Progress on the Development and Testing of a Hermetic Retinal Prosthesis." German Retina Implant Foundation International Symposium on Artificial Vision, Bonn, 2009.

S.K. Kelly, P. Doyle, O. Mendoza, W.A. Drohan, G.W. Swider, D.B. Shire, J.L. Wyatt, J.F. Rizzo, III. "Improved Class A Based Transmitter System for Wireless Retinal Implant Data Telemetry." IOVS, Vol. 50: 4578, 2009.

Selected Invited Seminar Lectures

"High-channel-count Retinal Prosthesis for the Blind," VA-University of Pittsburgh Dean's Committee, August 28, 2014.

"Retinal Prosthesis for the Blind," MIT Enterprise Forum Pittsburgh, "Opportunities in Life Sciences," March 20, 2013.

"Advancements in the Development of a Retinal Prosthesis for the Blind." CCNY/GA Tech Joint Workshop on Man, Machine, and Motor Control for the Blind, 2012.

"Being Bionic: The New Prosthetics." Science for the Public, community television, 2011.

"Functional Vision for the Blind: The Boston Retinal Implant." Boston Chapter of the IEEE Society on Social Implications of Technology, 2008.